PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-192686
(43)Date of publication of application : 28.07.1995

(51)Int.Cl. H01J 43/20
H01J 43/06

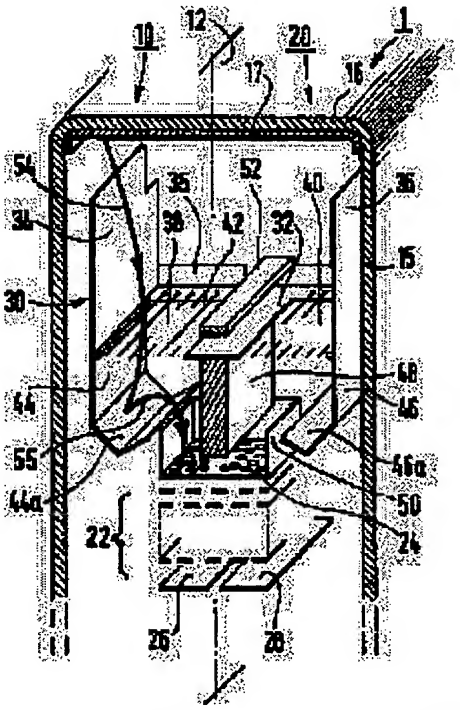
(21)Application number : 06-273681
(22)Date of filing : 08.11.1994

(71)Applicant : PHILIPS ELECTRON NV
(72)Inventor : L HERMITE PIERRE

(30)Priority
Priority number : 93 9313378 Priority date : 09.11.1993 Priority country : FR

(54) PHOTOMULTIPLIER

(57)Abstract:
PURPOSE: To provide a photomultiplier with improved photoelectron collecting efficiency.
CONSTITUTION: In a photomultiplier 1, upper parts 34, 35, 36 of an electrode 30 work as a focusing electrode to distribute photoelectrons to both sides of an axial face 12, and lower parts 44, 44a, 46, 46a form a collector part. The initial multiplication of photoelectrons is carried out in the parts 44a, 46a, which are curved toward the axial face direction, of the walls 44, 46 facing to the side face. Hole parts 38, 40 of a middle flat plate 32 of the electrode 30 are covered with a highly transmissive grid 42. The electrode is further provided with a center partitioning wall 48 spread near to an input diode 24 of the thin layer electron multiplier from the flat plate 32. A transverse rod 52 having a small cross section exists on the axial face 12 and a potential near the potential to the photoelectric cathode is applied to the rod.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It has the envelope which had at least two multiplication paths, was sealed and equipped the front inside front face with photoelectric cathode. It has a electron optics means by which the shot position from those photoelectric cathode divides the photoelectron which is separated and located from photoelectric cathode and is in one of the multiplication paths. Furthermore, it sets to the photomultiplier tube of an assembled die with the assembled-die electron multiplier which has at least one input dynode. It has an electrode containing two continuous parts, i.e., focal part, and collector parts in the direction in which this electron optics means keeps away from photoelectric cathode. Two parts are divided by the middle plate with at least two pores arranged at the both sides of an axial plane. this -- Each of those pore is covered with a penetrable high grid, and this focal part has two edges which faced the axial plane and were suitable in the direction of photoelectric cathode. This collector part had two edges which faced the axial plane and turned to the side face, and two edges suitable for the two side faces have bent in the direction of an axial plane, respectively. The photomultiplier tube characterized by having the septum which the field where primary multiplication of a photoelectron is performed was formed, and this collector part was substantially located further on the central axial plane, and has been extended in the direction contrary to photoelectric cathode from said middle plate by this.
[Claim 2] It is the photomultiplier tube according to claim 1 which said electron optics means is further equipped with the bar substantially located in the center about an axial plane, said focal part of an electrode insulates with this middle plate electrically, and this bar is arranged in parallel on said middle plate at it, and is characterized by constituting this bar so that it may have the potential near the potential of photoelectric cathode.
[Claim 3] The photomultiplier tube according to claim 1 or 2 characterized by constituting the edge of the input dynode of said electron multiplier so that an axial plane may be faced and it may enter to the location of the lower part of said bending part at least toward the direction of [upper].
[Claim 4] The photomultiplier tube given in claim 1 which said focal part of an electrode faces an axial plane, has edges other than facing up, and is characterized by the height of the direction of the photoelectric cathode of this edge being lower than the height of said upward edge thru/or any 1 term of 3.
[Claim 5] There are four multiplication paths and it has another same bar with the small cross section in the center of the focal part of an electrode. This bar is perpendicular to an axial plane, is parallel to a middle plate, and is electrically insulated with a middle plate. The photomultiplier tube according to claim 2 or 3 characterized by having another septum which two bars interconnected electrically, and the electrode has been further arranged at right angles to an axial plane, was substantially located in the center of an electrode, and has been extended in the direction contrary to photoelectric cathode from the middle plate.
[Claim 6] The photomultiplier tube given in claim 2 characterized by said bar being the strip configuration which has a rectangular cross section thru/or any 1 term of 5.
[Claim 7] The photomultiplier tube given in claim 1 characterized by consisting of a strip by which said bar was bent along the die-length direction, namely, formed V typeface cross section, and the bending base of V typeface is suitable in the direction of photoelectric cathode thru/or any 1 term of 5.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention has the envelope which had at least two multiplication paths, was sealed and equipped the front inside front face with photoelectric cathode, has a electron optics means by which the shot position from those photoelectric cathode divides the photoelectron which is separated and located from photoelectric cathode and is in one of the multiplication paths, and relates to the photomultiplier tube of an assembled die with the assembled-die electron multiplier which has at least one input dynode further.
[0002]
[Description of the Prior Art] This kind of photomultiplier tube is Europe patent official report EP-A -428215. It is indicated. This official report sets the photomultiplier tube with so many easy and cheap number of multiplication paths as the special purpose. The main applications of this type of photomultiplier tube are using for the contact mosaic equipment for defining a location in the space of a local light. When main, such light is emitted from the emitter located in the front face of each intensifier. If the assembled-die photomultiplier tube (namely, multi-path tubing) becomes still cheaper, this type of photomultiplier tube will be more economically used for such an application instead of the usual tubing. Furthermore, the photomultiplier tube of fundamental division tubing is small, and if tubing of the assembled die used reaches for every tubing and has the most uniform possible engine performance for every multiplication path, an optical event can position with a more sufficient precision. Another point which should be taken into consideration is making the horizontal leakage of the light between the multiplication paths of the same tubing as small as possible.
[0003] The assembled-die intensifier indicated by the aforementioned official report specifies distribution of the electron which takes the path from which a fundamental part differs with a electron optics means common to all paths based on the location injected from photoelectric cathode, and has become a certain thing which carried out extent satisfaction about the structural conciseness expected.
[0004]
[Problem(s) to be Solved by the Invention] The purpose of this invention is to offer the photomultiplier tube which improved the known thing, and is to offer the photomultiplier tube which has improved the collector efficiency of a photoelectron especially. It does not carry out that this invention introduces a photoelectron into the input dynode of thin layer multiplication equipment without the best collector efficiency, but it performs the first multiplication by the dynode of solid structure, and is based on the original idea of introducing a secondary electron into an electron multiplier after that. The first dynode determines most properties of the photomultiplier tube as known well.
[0005]
[Means for Solving the Problem] In order to attain this purpose, the assembled-die photomultiplier tube of this invention It has an electrode containing two continuous parts, i.e., focal part, and collector parts in the direction in which the aforementioned electron optics means keeps away from photoelectric cathode. These two parts are divided by the middle plate with at least two pores arranged at the both sides of an axial plane. Each of those pore is covered with a penetrable high grid, and this focal part has two edges which faced the axial plane and were suitable in the direction of photoelectric cathode. This collector part had two edges which faced the axial plane and turned to the side face, and two edges suitable for those two side faces have bent in the direction of an axial plane, respectively. The field where primary multiplication of a photoelectron is performed by this is formed, and it is further characterized by equipping this collector part with the septum which was substantially located on the central axial plane and has been extended in the direction contrary to photoelectric cathode from said middle plate.
[0006] In the photomultiplier tube of this invention, the electron injected by photoelectric cathode is electronically divided into the both sides of an axial plane by suitable electric field based on those shot positions. Consequently, the

photomultiplier tube becomes easy structure. After the first multiplication in the bending part of the collector part of this intensifier, since a secondary electron follows only an operation of the extract electric field which answer the electrical potential difference impressed to the input dynode of an electron multiplier, and spread into this collector part, this intensifier has the advantage of having good collector efficiency. This electrical potential difference is higher than the electrical potential difference actually impressed to an electrode. The front face where the first multiplication is performed does not receive ******, after putting back a part of these secondary electrons to this same front face.
[0007] It is constituted so that may have the bar with which said electron optics means of the photomultiplier tube is substantially located in the center according to the example advantageous [of this invention], concerning an axial plane further, this bar may be insulated as electrically in parallel as this middle plate by the focus part of an electrode at said middle plate, it may be arranged and it may have potential with this bar near the potential of photoelectric cathode. Such arrangement is convenient in order that a photoelectron may focus on the bending part of a collector part correctly.
[0008] Preferably, the edge of said input dynode of an electron multiplier faces an axial plane, and toward the direction of [upper], it is constituted so that it may enter to the location of the lower part of said bending part at least. Thereby, extract of the electron after the first multiplication and concentration of a up to [the input dynode of the multiplication machine of these electrons] are made best. This invention can be used in order to obtain the photomultiplier tube with the multiplication path arranged for example, on the symmetry target at the both sides of the axial plane of tubing.
[0009] It aims at offering 4 path intensifier. this invention -- further -- this intensifier It has another same bar with the small cross section in the center of the focal part of an electrode. It has another [which this bar was perpendicular to the axial plane, and it was parallel to the middle plate, and insulated as electrically as a middle plate, and two bars interconnected electrically, and the electrode has been arranged still at right angles to an axial plane, was substantially located in the center of an electrode, and has been extended in the direction contrary to a middle plate to photoelectric cathode] septum.
[0010] according to this example of this invention, the photomultiplier tube becomes the symmetry to an axial plane, that each side is equipped with two basic multiplication machines, and those both receive an electron according to the shot position from cathode according to an operation of the suitable electric field which spread fundamentally according to a compound operation of the bar of the small cross section which is a cross mold substantially.
[0011]
[Example] Next, an example is explained to a detail using a drawing. Drawing 1 is the sectional view of the part of the 1st example of the photomultiplier tube by this invention. The photomultiplier tube 1 is equipped with two fundamental photoelectron multiplication machines 10 and 20 arranged about an axial plane 12 at the symmetry. It has a front face 16 and contains the envelope 15 of the seal mold with which photoelectric cathode 17 is arranged on the inside front face. This photomultiplier tube contains the tabular electron multiplier 22 which has a through tube further. This electron multiplier 22 is divided into the part of two symmetry about an axial plane 12, and the input dynode 24 and two anode plates 26 and 28 are allotted.
[0012] According to this invention, a electron optics means divides a photoelectron into the left-hand side or right-hand side of an axial plane 12 according to the shot position of the photoelectron from photoelectric cathode, each multiplication path, i.e., drawing. This electron optics means consists of electrodes 30 equipped with the plate 32 of ******** in this example, this electrode had the wall surfaces 34 and 36 in alignment with each of two edges of a plate 32, and this wall surface spread in parallel with an axial plane 12, and it has started in the direction of photoelectric cathode 17. This plate 32 has two pores 38 and 40 covered with the grid 42 to which it is located in the both sides of an axial plane 12, and each has high permeability, the 1st part, i.e., focal part. As shown in drawing, this grid can be formed with the thin line stretched from the side of a plate 32 in other sides so that the active jamming over passage of an electron could be disregarded.
[0013] An electrode 30 contains, the 2nd part, i.e., collector part. This collector part contains the edges 44 and 46 which faced the axial plane 12 and turned to the side face, and is each bending partial 44a. And 46a It has extended toward the axial plane, and it is constituted so that this may realize primary multiplication of a photoelectron.
[0014] The lower part of an electrode contains further the central septum 48 which was located in the axial plane 12 and has spread in the direction contrary to photoelectric cathode 17 from the plate 32 about the collector part 32, i.e., a plate. The edge of this central septum 48 is located near the input dynode 24 of an electron multiplier 22. The input dynode 24 has two edges 50 which have started in the direction of photoelectric cathode 17. These two edges are the aforementioned bending partial 44a desirable at least. And 46a It is constituted so that it may enter to a lower location.
[0015] A electron optics means will become perfect in preparation for the last about a bar 52. This bar 52 is a thin strip which has a small cross section as compared with that die length, separates on a plate 32 as slightly in parallel as this plate 32, and is located in the central part on an axial plane 12 here. It insulates with an electrode 30 electrically, and a

bar 52 is equal to photoelectric cathode 17, or can give the potential near it.
[0016] It is made for such a electron optics means to distribute a photoelectron all over two fundamental photoelectron multiplication machines 10 and 20. It is bending partial 44a of the edges 44 and 46 with which the first multiplication turned to the side face as the first one multiplication path was displayed on drawing by the line 54. And 46a It is mainly carried out. Only the electric field acquired by the input dynode 24 of an electron multiplier 22 exist in the space established in the bottom of a plate 32, and the input dynode 24 gives potential higher than the potential of an electrode 30. The potential difference between a dynode 24 and an electrode 30 is 100V. Such extract electric field are bending partial 44a. And 46a It is made in order to make the back secondary electron of multiplication jump out, and this electric field act so that a secondary electron may go to the input dynode 24 of the multiplication machine 22 by the central septum 48. The path of a secondary electron is expressed as the line 55.
[0017] Since the first multiplication is performed as multiplication effectiveness becomes max in the dynode of solid structure, this type of assembled-die photomultiplier tube has good collector efficiency as compared with the conventional photomultiplier tube. The first multiplication has main roles in the photomultiplier tube as known well.
[0018] Drawing 2 is drawing showing the assembled-die 4 path photomultiplier tube which are other examples of this invention. In this drawing, the part about the electron optics means of tubing, i.e., the part which distributes a photoelectron over four fundamental paths, is shown. The same possible reference number is given to the part which has the same function as what was shown in the example of drawing 1 .
[0019] The illustrated electrode 60 is equipped with the square plate 32, and has two edges 34 which were prolonged in parallel with an axial plane 12, and have started in the direction of photoelectric cathode, and a focal part with 36. A plate 32 has four pores 38 symmetrically located in two-line two trains about the axial plane 12, 39, and 40 and 41. The pores 38 and 39 of the same side of an axial plane 12, or 40 and 41 are separated from the plate 32 by another septum 49 by which the direction contrary to photoelectric cathode, i.e., drawing, spreads out caudad. This septum 49 of another is located in the central part of an electrode 60, and forms the space which four independent paths in which the photoelectron is distributed over the whole surface with the septum 48 of the beginning of a mold as shown in drawing 1 produce. Furthermore, each pore 38-41 is covered with the grid which has the high permeability formed from the thin line 42 stretched in the field of a plate 32 here.
[0020] An electrode 60 has the part located below the level of a plate 32 called a collector part here. This part has the edges 44 and 46 which faced the axial plane 12 and turned to the side face. The edge of these edges 44 and 46 is bending partial 44a which has bent in the direction of an axial plane 12, respectively. And 46a It contains. Furthermore, these bending parts become the front face which realizes multiplication of the beginning of a photoelectron here. Therefore, these act as a dynode of the beginning of the photomultiplier tube.
[0021] As shown in the example of drawing 1 , a plate 32 is closely alike and the bar 52 of a small cross section is arranged on an axial plane 12. This bar can give the potential near the potential of photoelectric cathode. Therefore, this bar 52 is useful to acquiring the suitable electric field for specifying distribution of a photoelectron in the both sides of an axial plane 12. Similarly, although another bar 53 is located in the midpoint of an electrode 60 as well as a bar 52, it is perpendicular to an axial plane 12. Bars 52 and 53 are connected electrically. This bar 53 is located in parallel with separating slightly with a plate 32 and insulating with this. This bar 53 generates distribution of electric field parallel to an axial plane 12, and has the operation to which it is made for a photoelectron to be distributed over a pore 38 or either of 39 according to the location at the time of a photoelectron injecting from photoelectric cathode. This bar 53 of another has the operation to which it is made for a photoelectron to be distributed over a pore 40 or either of 41 according to the location at the time of a photoelectron injecting from photoelectric cathode.
[0022] As shown in the example of drawing 1 and drawing 2 , it has the edge 35 located at right angles [the plate 32 of an electrode] to an axial plane 12. These edges have the upward edge 34 and height lower than the height of 36. Therefore, suitable electric field to distribute a photoelectron all over the both sides of an axial plane 12 are realized.
[0023] You may be other configurations although the aforementioned example explained the bar as an even strip. For example, it is 52a to drawing 3 . It carries out, and V typeface bends along the die-length direction, and as shown, it may be located so that the base may point out the direction of photoelectric cathode.
[0024] Other modification of the description of this invention is easy for this contractor, and these modification is included in the range of this invention.

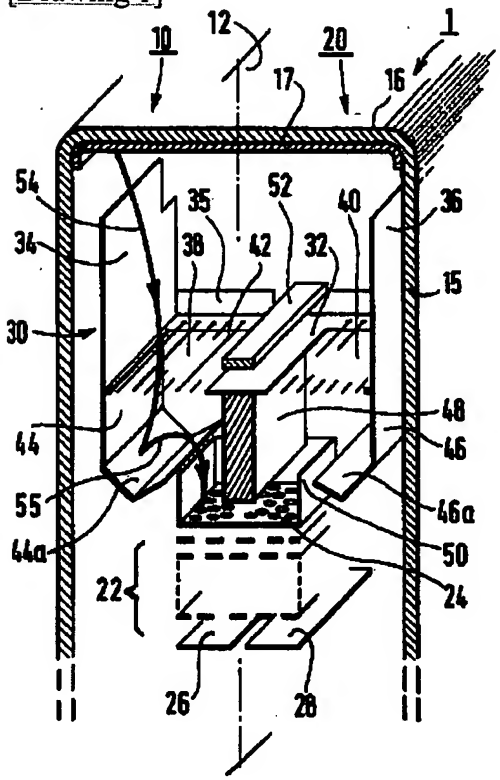
[Translation done.]

* NOTICES *

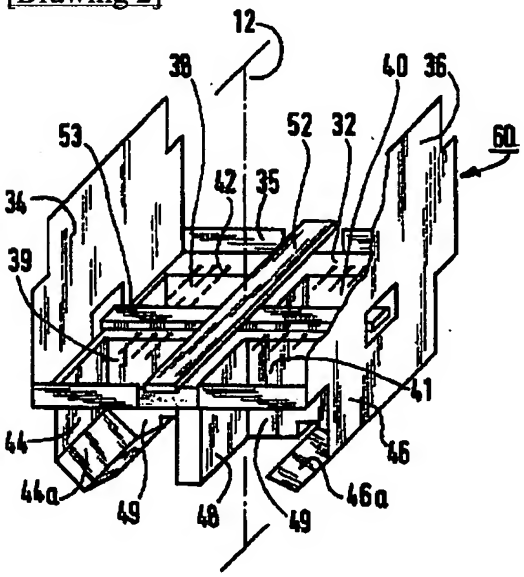
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

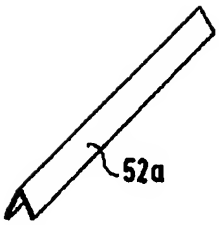
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]